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OFFICE OF NAVAL RESEARCH

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Task No. NR 105-579

ANNUAL REPORT

in support of

Joint Army/Navy Air Crew Impact Injury Prevention Program

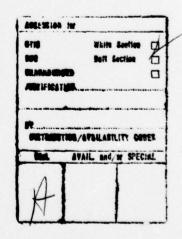by

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01 November 1976

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1.0 INTRODUCTION

QEI presents herein the annual report for technical support of the Joint Army/Navy Air Crew Impact Injury Prevention Program. This report describes the work performed by QEI personnel from 1 November 1975 to 1 November 1976. A list of the major sections are given below:

2.0   HORIZONTAL ACCELERATOR

The principal activity pursued during this report period concerns the Horizontal Accelerator project. Various programs, investigations and studies in support of the project are described in the sections listed below:

1. 3-D Transformation Program

2. X-Ray Anthropometry Program

3. Conversion/Scaling Program

4. Dynamic Response Study: Effect of Onset and Duration

5. Signal Vector Alignment Program

6. Horizontal Sled Test Program

7. Principal Component Analysis - Eigenvalue/vector Program

8. Filter Routine for Horizontal Sled Accelerometer Data

9. Special Plot Project - "Human-Beam"

10. Model of Neck and Head Program "MONAH"

11. Sorting and Information Retrieval Program

12. Hinge Point Determination for Gy Runs

13. Additional Programs and Studies

   a. Regression Analysis of Peak Rotational Acceleration and Velocity Program

   b. Spectral Analysis Program

   c. El Centro Data

   d. NCEL Head Injury Model Program

   e. Special Plots of T1 Variables

2.1 3-D Transformation Program

The 3-D Transformation Program written during the previous reporting period was first modified to handle changes that were made in the input data; then, additional modifications were made in the program to handle Easy-Flo input. This program is now in production status.

2.2 X-Ray Anthropometry Program

The X-Ray Anthropometry Program written during the previous reporting period has been modified by the addition of an update routine to generate existing anthropometry data tapes. This program is now in production status, with all available X-ray data on human subjects being processed as received.

2.3 Conversion/Scaling Program

The Conversion/Scaling Program written during the previous reporting period was first modified to remove blank frames from the microfiche output by the plot subroutine. This program is now in production status with data up through run LX1661 being converted.

2.4 Dynamic Response Study: Effect of Onset and Duration

Two separate studies were undertaken to determine the effects of dynamic response to onset and duration of impact acceleration on subject reaction. The first study involved four subjects, while the second involved six. All basic data on the reactions of the two groups of subjects have now been processed and analyzed.

2.5 Signal Vector Alignment Program

A paper describing the algorithm used in this Signal Vector Alignment Program, showing program outputs, was prepared and submitted to the American Federation of Information Processing Societies. This program written during the previous reporting period was modified by the addition of a routine to prepare transformed variables for input to the program. Four different transformed runs were input to this program, and the resultant outputs were analyzed statistically and by regression techniques.

2.6 Horizontal Sled Test Program

This program written during the previous reporting period is in production status and has been used to generate a history report through run LX1265. Further runs with this program have created an updated history report through run LX1661. Microfiche copies of this report have been created.

2.7 Principal Component Analysis - Eigenvalue/vector Program

The Principal Component Analysis - Eigenvalue/vector Program, obtained from a canned program in the previous reporting period, has been thoroughly documented during the present reporting period. This program is now in production status.

2.8 Filter Routine for Horizontal Sled Accelerometer Data

A filter routine for horizontal sled accelerometer data has been incorporated into the variables program as a selectable option. This routine has been used to filter certain runs in connection with a study for the University of Michigan. This

filter routine has also been used to filter all runs used for the Dynamic Response Study - Effects on Onset and Duration and to filter certain photographic variables. Comparison plots of filtered vs. unfiltered data were created for these photographic variables.

2.9 Special Plot Project - "Human-Beam"

A computer program was written, debugged and tested to compare the response of the human neck to that of the dummy's neck when both are subjected to the same impact acceleration. This program is now operational and in production status.

2.10 Model of Neck and Head Program "MONAH"

A program has been written, debugged and tested to model in two dimensions the motion of the human neck and head under impact acceleration. This program determines displacement and velocity dependent force constants and interrupt angles which in the least squares sense accommodate the forces causing neck and head motion under impact acceleration. The constants produced by this program have accurately described neck and head motion during acceleration. Attention is now centered on producing a three dimensional analogue of this model and incorporating the Easy-Flo and hinge point data into the model and program.

2.11 Sorting and Information Retrieval Program

A program has been written, debugged and tested to sort records and retrieve information from the master tape produced by the History Report Program. This Sorting and Information

Retrieval Program is capable of sorting on different keys and generating reports in a number of different forms using the History Report Master Tape as the data base.

2.12 Hinge Point Determination for Gy Runs

A program has been written, debugged and tested for the calculation of the locations of a hinge point in the neck anatomical coordinate system and of one in the head anatomical coordinate system such that these hinge points best fit the data from the + Gy impact acceleration runs. A report will be written describing the algorithm used for calculating hinge points in the neck and head anatomy from three dimensional NAMRL data.

2.13 Additional Programs and Studies

(including those virtually completed in the previous reporting period)

The Regression Analysis of Peak Rotational Acceleration and Velocity Program is in operational status and has been used to analyze runs included in the Dynamic Response Study: Effects on Onset and Duration. The Spectral Analysis Program has been in production status since last January. Data received from El Centro has been processed; the required variables have been calculated and plots made and all output has been sent to El Centro. The NCEL Head Injury Model Program was successfully transferred to Slidell; the program has been compiled and the sample problems have been correctly executed. Resultant translational acceleration and resultant angular acceleration were calculated for six runs and then special plots were created of these variables and peak resultant acceleration was determined.

3.0   SLED RUN MOTION PICTURE DIGITIZATION

Photographic data for 633 full runs on humans were completely processed during this and the preceding reporting periods. During this and the preceding reporting periods human runs were completely processed for camera one through LX1639, camera two through LX1639 and camera three through LX1600. Run LX1391, a dummy run, was processed as a three day accuracy/reliability test of data. The results of this test were evaluated and a report submitted. Four human runs for system check, i.e. comparison with Elgin data were completed and nine dummy study runs were processed during this report period. Four animal runs, LX1234 - LX1237, and eighteen head nod runs, LX0684 - LX0686, LX0842 -LX0849, LX0977 - LX0979, LX1434, LX1437, LX1476, and LX1478 were completely processed during this reporting period.

Certain hardware problems were encountered during this reporting period. The scan converter (video) section of the photodigitization system was inoperable for a time, so the photodigitizer control unit and film analyzer projector head were returned to the factory for a complete checkout.

4.0 EKG DATA PROCESSING

Modifications to the EKG Analysis Plot Program as recommended by the Medical Department have been made and completely checked out. A group of 27 EKG runs were initially processed through the EKG Detection Program and then through the modified EKG Analysis Plot Program to produce the final plotted output. Programs have also been written first to generate à baseline-corrected averaged PQRST wave form epoching on the R wave onset and second to cross-correlate this averaged wave with each of the PQRST complexes occurring after the sled firing. The debugging and checkout of the Average Wave (AVGWV) Program and of the Cross-Correlation (XCORR) Program have been completed and these programs have now been integrated into a modified version of the EKG Detection Program.

5.0 BLOOD CHEMISTRY DATA PROCESSING

A program to update the Blood Chemistry Data Base has been written, debugged and tested and is now operational. A COBOL program has been written, debugged and tested to generate a report of the current master file of the Blood Chemistry Data Base. This program includes a subroutine for writing out a tape to be used as input to future programs. A program has also been written and checked-out to calculate statistics from the data in the Blood Chemistry Data Base. The Blood Chemistry Data Base has been updated to include all of the test forms received through August 1976. New statistics were calculated for this updated Blood Chemistry Data Base using the new statistics program.

6.0 MEDICAL HISTORY INFORMATION SYSTEM

All Medical History forms through run LX1661 have been key-punched and a Medical History tape has been formed from the Medical Form cards and updated to the present run. A program for performing medical form data analysis (MFDA) has been written and debugged and is now fully operational.

7.0 MANAGEMENT INFORMATION SERVICES

For this entire reporting period a continuous review of
management information flow has been conducted. Recommendations
were made to the Officer in Charge, NAMRL when necessary. Charges
for services rendered by NASA were reviewed and all discrepancies
were questioned; any overcharges were recouped. The budget exe-
cution was continuously monitored with periodic reports being
provided to the Officer in Charge. Cost estimates for rearrange-
ment and alteration and for some minor construction were prepared
and cost effective recommendations were made to the Officer in
Charge. Budget projections for the transition quarter and for
FY's '77 and '78 were prepared which incorporated trends through
the last fiscal year. The proposed Support and Loan Agreement
with NASA (MAF) was reviewed and recommendations were made to the
Scientific Director. A facilities requirements forecast for
submission to NASA was also prepared.

8.0   1108 REMOTE TERMINAL OPERATIONS

All previously instituted procedures were followed with
no changes during this entire reporting period. All jobs are
followed through the system and checked for possible 1108 system
error. If there appeared to be a system error, a Suspected Error
Report - SER - was submitted to the Control Computer Complex and
attempts were made to recoup charges for jobs affected by SER's.
Some 86 SER's were submitted during the report period and charges
were backed out on almost all of them. Job turnaround time has been
generally satisfactory.

9.0 SCIENTIFIC-TECHNICAL EDITORIAL SERVICES

The final typing, photography and editing was performed on two scientific papers, "The Effect of Duration Rate of Onset and Peak Sled Acceleration on the Dynamic Response of the Human Head and Neck" and "Comparison of Kinematic Parameters Between Hybrid II Head and Neck System with Human Volunteers for - Gy Acceleration Profiles". Research and writing was done on the Rhesus Monkeys Report and on the -Gx Vector.

10.0 SIMULATION OF EFFECTS OF DIFFERENT TYPES OF CRASHES ON LIVING HUMAN BODIES

(This section describes work performed during the present reporting period by Louis D'Aulerio of Philadelphia, PA.)

Work continued to validate the computer program begun previously to simulate escape system trajectories. This program was updated and modified to simulate several different types of ejection seats. The trajectory simulation program was used to conduct a computer study, requested by the Navy Accident Investigation Board, of an accident involving an ejection seat.

Assistance was given to the effort to validate a mathematical computer model to simulate the response of the living human body to crash situations.

Another computer study was performed, also requested by the Navy Accident Investigation Board, of a second accident involving an ejection seat. Computer predictions were obtained for a track test being conducted on an ejection seat.

Assistance was given in preparing a paper on the computer model of the response of a living human body to crash situations. This paper will discuss the effectiveness of mathematical models of the human body's reactions. Modifications to the Ultrasystem's "Crash Victim Simulation-Light Aircraft" computer program were made so that it would correctly model the anthropometric characteristics of the test subject.

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This annual report covers the mathematical analysis and computer-related effort supplied by the originator in support of the Joint Army/Navy Air Crew Impact Injury Prevention Program.

The mathematical analysis, coding and debugging were performed for the following programs connected with the Horizontal Accelerator data processing effort; 3-D Transformation Program, X-Ray Anthropometry Program, Conversion/Scaling Program, Dynamic

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20. ABSTRACT   (cont.)
Response Study: Effect of Onset and Duration, Signal Vector Align-
ment Program, Horizontal Sled Test Program, Principal Component
Analysis - Eigenvalue/vector Program, Filter Routine for Horizon-
tal Sled Accelerometer Data, Special Plot Project - "Human-Beam,"
Model of Neck and Head Program "MONAH", Sorting and Information
Retrieval Program, Hinge Point Determination for Gy Runs, and
other smaller programs and studies. Sled Run Motion Picture
Digitization was completed for 633 full runs on humans. Modifica-
tions were made to several of the present EKG Analysis programs
and two new programs to process EKG data - one to generate an
averaged wave form and the second to cross-correlate this averaged
wave to regular wave complexes - were written and debugged. A
new program to update the Blood Chemistry Data Base was written
and debugged and this data base was then updated and statistics
calculated for the new data base. A number of tasks in the
Management Information area were performed and editing was per-
formed on several scientific papers. Work was also done to
simulate the effects of different types of crashes on living
human bodies, with computer studies of actual crashes being
performed.

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